

NEED TO KNOW

a national security newsletter

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Power Play

INEEL scientists develop long-lasting battery for reconnaissance missions

Contributed by Ethan Huffman



In early January, 75 members of America's elite Special Operations Force commandos spent eight days behind enemy lines gathering military information and conducting raids on Taliban and Al-Qaida hideouts in the Zawar Kili region of Afghanistan. Equipped with the most technically advanced gadgetry for their mission including laptops, night vision goggles and remote surveillance items, they proceeded to identify cave complexes and secret tunnels before calling in air strikes. Although the mission was successful, at least one element hindered their ability to remain on the ground longer and continue with their strategic reconnaissance mission. That element was battery power. Today's military, including much of the work done by Special Operations forces, rely on portable, battery-powered equipment. Commandos often employ devices such as GPS receivers, smart missiles and

chemical agent monitors. The challenge is to supply advanced equipment with a reliable battery that can perform for extremely long hours in a variety of weather conditions. Everyday alkaline batteries are not capable of meeting these stringent requirements. Even

the more advanced lithium-ion rechargeable batteries run out of power within a few days. However, battery research and development being done at the INEEL is revolutionizing the internal makeup of batteries and could substantially improve the length of time a battery lasts.

Such developments have garnered a keen interest from military and national security officials who see great potential for the use of these new lithium-solid electrolyte batteries in future intelligence missions.

How Batteries Work

A typical battery can be thought of as having three compartments or fields, the anode, the electrolyte and the cathode. The secret to an ordinary battery's success involves the chemical reaction that occurs inside the anode. When an electronic device is turned on, a complete circuit is made, and negatively charged electrons flow from the anode, out into the electronic device giving it power, and back into the battery's cathode. At the same time, positive ions are

See **BATTERIES**, page 2



INEEL scientist Mason Harrup has formulated a solid polymer electrolyte that could revolutionize the battery industry.

IDAHO NATIONAL ENGINEERING AND ENVIRONMENTAL LABORATORY





Harrup holds a lithium anode coated with the solid polymer electrolyte. The polymer's chemical makeup works as an insulator for electrical currents, but maintains the ability to conduct positive ions.

BATTERIES *(continued from page 1)*

also being sent from the anode to the cathode via the electrolyte field. As electrons and ions build up in the cathode, the battery begins to lose its power.

The amount of time it takes for a battery to run out of power depends on two properties. The first, is the amount of power used up when an electrical device is turned on. The second, however, occurs because of a concept known as “battery drain.”

Most everyday alkaline batteries use a liquid-based solution or paste electrolyte. Battery drain occurs because the liquid electrolyte is electrically conductive and allows electrons and ions stored in the anode to pass through freely, even when the device is turned off. Since both the electrons and ions can move through the electrolyte, the battery runs down while it is still off.

In fact, some batteries can lose up to 15 to 20 percent of their power in a single day even when they are not being used. This may explain why a cordless phone will go dead overnight even if it is not used, but left off the charger. It also explains why

high-power devices, such as those used by the military, must have their batteries replaced or recharged every few days even if they are not always on.

According to Mason Harrup, an INEEL chemist, “Even if you only talk on a radio two minutes a day and then turn the device off, the battery will still lose power because electrons and ions will drain through the highly conductive liquid electrolyte field. Within a few days batteries lose so much power they have to be recharged or replaced.”

While technology advancements have allowed more and more gadgetry to become portable, there has been a stalemate in the advancements of long-lasting batteries.

For Special Operations missions, batteries that can run specialized electronic equipment for longer periods of time could mean the difference between life and death for soldiers and civilians. That’s why military and national security officials are excited about the work being done at the INEEL.

What’s Going On at the INEEL?

Five years ago, several INEEL scientists made an impressive

discovery. While working on another project, they formulated a solid composite electrolyte, based upon the polymer MEEP ([bis (methoxyethoxyethoxy) phosphazene]), which conducts positive ions very well, yet also stops negatively charged electrons.

The polymer’s chemical makeup works as an insulator for electrical currents, but maintains the ability to conduct positive ions. Therefore, electrons can’t leak through the electrolyte causing the battery to lose additional power.

According to Harrup, who discovered the electrolyte, this new electrolyte could revolutionize the battery industry.

“Basically, the chemical makeup is such that the electrolyte could allow batteries for electronic devices such as laptops and cell

phones to sit unused for up to 500 months between charges,” said Harrup.

According to Harrup, the new battery is more efficient, using power only when the device is physically on. That could mean that batteries transported from the U.S. to Afghanistan, for instance, could remain fully charged without losing any power during the trip. It could also mean that radios, laptops, or other electronic devices that are used for short periods of time in field and then turned off wouldn’t lose any power until they were turned back on.

And because the polymer begins in a liquid state, it could be molded to meet virtually any application or battery size.

Harrup and his team are currently perfecting the polymer so it can be outfitted for high-drain electronic devices such as

Harrup examines an organic reaction product, which is one of the building blocks of his newest polymer design.



“We have just developed a new class of phosphazene polymers that selectively replace critical oxygen centers with sulphur centers. This enhances transport, as the lithium ions do not cling as tightly to sulphur as they do to oxygen.”

laptops, cell phones, GPS units, and other military and consumer goods. The team is looking into ways to improve the routes positive ions take when they travel through the electrolyte. Right now, too few ions travel through the electrolyte at one time to meet the demands of high-drain devices such as cell phones or laptops.

Batteries built with the current generation of this polymer composite, however, are capable of running low-drain devices such as watches and pacemakers that require a constant supply of energy over an extended period of time.

“We feel that in the foreseeable future, maybe in the next two to four years, we’ll have a battery capable of running a high-drain device,” said Harrup.

How They are Made

The solid electrolyte produced at the INEEL is a combination of a unique liquid polymer and a ceramic powder. When properly mixed, a translucent, nontoxic, flexible electrolyte membrane is produced.

In the past, other researchers have made attempts at using similar polymers, called

polyphosphazenes, in battery construction. Until now, researchers have been unsuccessful in strengthening the liquid polymer to hold its shape. This is critical because the electrolyte must also serve to physically separate the electrodes or the battery will short out and immediately “die” – sometimes with explosive results.

At the INEEL, Harrup and his team used the ceramic powder to form a skeletal structure around the conductive portions of the liquid polymer. When dried, the ceramic powder becomes flexible and sturdy, while the conductive portions of the polymer weave throughout the structure like ribbons.

The combined elements allow the electrolyte to transfer positively charged ions easily, but prevent negatively charged electrons from leaking through, draining the battery.

Longer-lasting power is not the only benefit of these batteries. The solid electrolyte inside will eventually replace the liquid solution, generally composed of sulfuric acid or toxic organic chemicals, found in conventional batteries. The team is designing the new batteries so they can be exposed to extreme elements such as adverse weather climates, humidity and pressure fluctuations without the fear of a toxic or dangerous leak occurring. The batteries are also expected to weigh less than conventional batteries.

The Next Step

To date, Harrup and his team have secured one patent, an Energy@23 and a Bright Light award for their work. Currently,

two more patents have been submitted for approval, and a fourth is being prepared.

“We feel that the future is very bright for these batteries. Most of the technical challenges have been met in the laboratory setting, and the process of obtaining the patents needed to protect our invention are well underway,” said Harrup. “Now we have to begin to address the issues related to making and marketing a practical battery.”

As U.S. Special Operations and other military missions continue throughout the world, and as more technology becomes portable, the need for an energy source that can meet modern-day challenges exists. With any luck, the future development of a long-lasting battery looks bright indeed.

Mason Harrup
harrmk@inel.gov



The polymer begins in a fluid-like stage, which is why it conducts so well. When combined with a ceramic powder, however, it gains the mechanical stability required to form a usable battery.



Baring your identity

Antibody screen to crack down on drug test cheaters

Contributed by Kendall Morgan

All those tricksters tempted to cheat on their next drug test – by clandestine swapping of sample vials or by slipping chemical additives into the mix – should think again. INEEL scientists Vicki Thompson and Diane Key, in collaboration with Miragen, Inc., have developed a new method of drug detection that promises to spoil their evasive plans.

With just a few drops of saliva, the INEEL scientists' method signals drug test results along with the donor's identity. Their initial findings were reported in the June 2002 publication of the Office of the National Drug Control Policy's Conference Proceedings, "Counterdrug Research and Development: Technologies for the Next Decade." The key ingredient in their method is a test strip that highlights individual-specific auto-antibodies (ISAs) – a bar-code-like pattern of proteins unique to each person.

"Everyone has them," Thompson said. "And even identical twins have different patterns." What's more, the antibody profiling technique delivers the undeniable mark of an individual in just a few simple steps. "In fact, it's so easy, I've had fifth-graders do it," Thompson added.

Traditional drug testing methods don't measure up

In contrast to Thompson's test, traditional methods of

drug testing generally seek out traces of drugs in urine. That means donors must be afforded the privacy of a bathroom, a factor that can give undue opportunity for sample manipulation or substitution.

In recent years, an entire drug test evasion industry has sprung up, making the prospects even simpler for would-be test fakers. "Just do a web search for drug testing and page after page of products pop up that can be added to urine or that you can drink – and the test comes out clean," Thompson said.

And that's no joke. For as little as \$20, one can order special concoctions promising to flush all unwanted toxins in an hour. In lieu of that, the web-based company, Assured Testing Resources, offers drug-free substitution urine for a mere \$35, handily packaged for ease of carrying and delivery at "proper submission temperature."

Cheating is a big problem, Thompson said, particularly in environments such as correctional facilities where inmates are routinely tested. "But with saliva," Thompson added, "they won't be able to do that as easily."

Not only does the INEEL team's saliva-based test make doctoring test results difficult, but even if a decoy sample were to get in the mix, it wouldn't pass muster. The protein bar code would reveal the mismatch when compared with the taker's unique

antibody "fingerprint," and the fraudulent sample could be eliminated in a matter of hours.

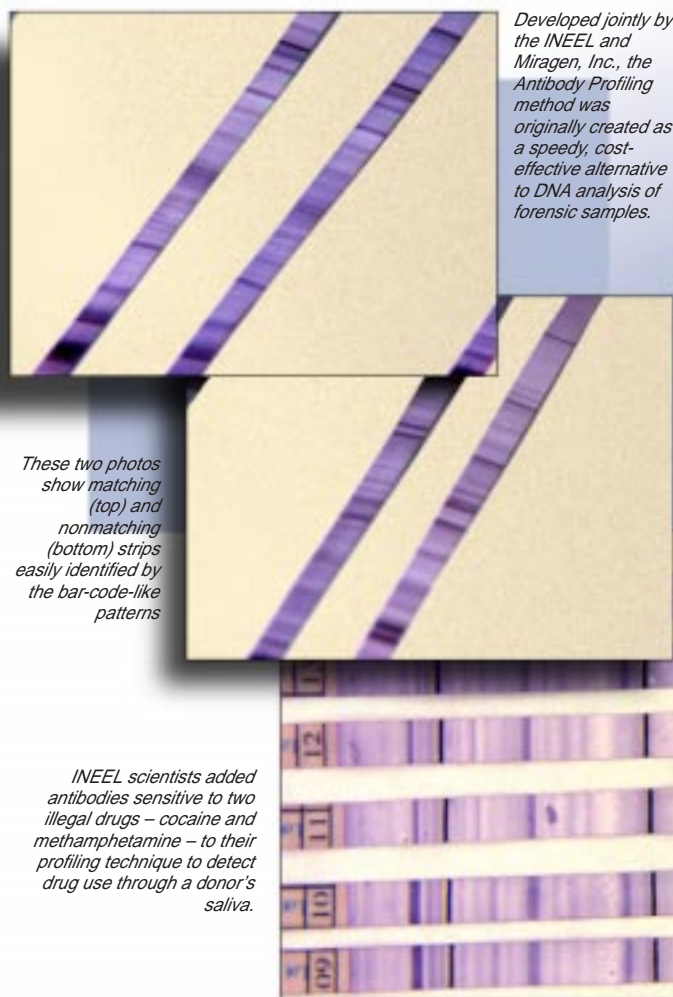
Identity in a snap

The profiling test – developed for medical use by the Irvine, California-based biotechnology company, Miragen, Inc., in 1995 – relies on proteins embedded on a strip that recognize and hang on to antibodies present in all body

fluids. A series of chemical washes stains the bound proteins, highlighting an array of clear, blue bands.

The INEEL group got involved in 1997 to explore the technology as a forensic tool. First, they looked to the test as an alternative to DNA-based methods of matching suspects to evidence gathered at crime scenes.

The profiling test proved to be an incredibly accurate indicator of identity, even under extremely adverse conditions, according to the team's earlier work. They were able to match adulterated blood samples – mixed with gasoline, urine, animal blood and even other human samples, conditions mimicking those often found at



crime scenes – to a person an impressive 91 percent of the time.

Though there are a large number of bands in the

antibody ladder, in most cases, identities can be assigned at a glance because of distinctive spots characteristic of an individual – a thick band here

or a missing one there, Thompson said. And the test costs less, takes less time, and requires less technical know-how than DNA-based methods – not to mention its versatility.

“The test can literally be performed in the back of a pickup truck and still work,” Thompson said.

While the test has not yet been approved for admission in court, the team’s success led Thompson to pursue other potential law-enforcement applications for the identity screen.

Building a better drug test

To link the antibody test to one able to detect traces of drugs, the INEEL scientists first adapted Miragen’s method for blood screening for use with saliva. Four lucky volunteers then enjoyed sweets – including butterscotch, lemon candy, and chocolate – to ensure these common indulgences didn’t mar the ID’s accuracy. Next, they partook of alcohol, coffee, and even brushed their teeth just before handing over a wad of spit.

The antibody test held true. The culinary splurging had no effect on the outcome of the identity screen.

Add antibodies sensitive to two illegal drugs – cocaine and methamphetamine – into the mix, and a new drug test was born. Further tinkering will be required to perfect the method, but so far, the future looks bright for drug test profiling.

Despite its many benefits, the test does have one drawback – the time it takes to process. Though speedier than DNA-based identity methods, the antibody profile technique is lengthy compared to drug-

testing methods lacking an identity screen. The new drug test takes five hours to generate compared to five minutes for urine-based methods.

Still, the reaction from law enforcement officers has been overwhelmingly positive so far, Thompson said. The added identity information outweighs the cost in time.

And there may be ways around the additional hours.

“I’d love to make it faster,” Thompson said. “Physically capturing the antibodies on the strips takes time, but if we could miniaturize things with chip technology, we could get the testing time down to as little as ten or fifteen minutes.”

Expansive possibilities

The true test of their method is yet to come. Though no final plans have been made, Thompson hopes to bring the identity-drug screen to a real-world situation, trying it out on inmates and comparing the results to those of the standard method.

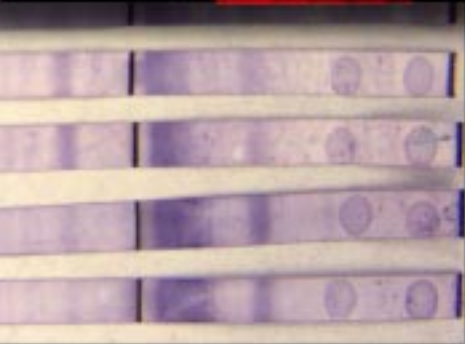
And don’t be surprised if antibody profiles find their way to other law enforcement arenas. Wildlife organizations have already expressed interest in applying the method to link poachers to their illegal prey, Thompson said, and the test could be used to ensure sporting dogs are clean and sober before a big race.

So take some good advice – stay on the straight and narrow.

Vickie Thompson
thomvs@inel.gov



INEEL scientists Vicki Thompson (above) and Diane Key, in collaboration with Miragen, Inc., have developed a new method of drug detection that promises to spoil the evasive plans of dishonest drug testees.



Achievements, Accomplishments, Acknowledgements



All in the Family

Special Programs' David Crandall was the Idaho Long-Range Rifle Champion for six years. But he lost in 2002 – coincidentally, to another National Security employee. Crandall would have been more disappointed, except that it was his wife, Chris Crandall of Counterintelligence, who beat him.

The husband/wife sharpshooter team has excelled in this extreme sport. In fact, David Crandall traveled to England to compete in the British National Championship, representing the United States in a match that included the world's best marksmen.

At 1,000 yards – the distance to the target in long-range competition – the 6-foot by 6-foot target appears, even through the gun sight, as not much more than a speck. On that board are concentric circles, each smaller and representing a

higher value. The center ring – worth ten points – measures a mere 20 inches in diameter. Within that center ring is the X-ring. It is not worth additional points, but serves, if necessary, as a tiebreaker. If two competitors shoot the same score, the number of still-more-difficult X shots will decide the winner.

"The wind has a huge effect at that distance," said Chris Crandall. "And in Idaho, it is always windy." Flags at various distances help the competitors make adjustments for wind

changes in an effort to keep on target.

The Idaho Championship is comprised of three matches, two that allow telescopic sights and one that requires an open iron sight. Competitors shoot 20 rounds in each match and the combined high score wins. Many wear slings that help steady the rifles while shooting in the prone position. One popular sling was designed and patented by David.

David Crandall's first match score was a perfect 200, with an equally impressive 12X.

"I thought, 'Oh well, there he goes again,'" said Chris. But her first round was 194, 8X. Chris was shooting a custom 6.5 x 284 caliber rifle, built by David, and recently rebarreled. Both shoot custom-loaded rounds. Something happened in the next two matches; David suffered some ammunition failures. Chris remained steady, even in

David Crandall builds the rifles that he and his wife, Chris, shoot. Shown are Chris's custom 6.5 x 284 caliber rifle (top) and David's custom 308 caliber (bottom), which he used in this year's British National Championship.



increasing winds. She won with an overall score of 563.

What made Chris' achievement all the more remarkable was that she was recovering from a broken wrist. She had only practiced once the week before and had only shot 23 rounds before her left supporting wrist ached.

"I think he would have been disappointed," said Chris, speaking of David's loss, "except that we kept the championship in the family."

Other News

- Defense Systems' employee and Electronic Combat Systems Integration (see *Need to Know July 2001*) team member Lance Murri recently supported the Millennium Challenge 2002 – the largest and most complex joint and service experiment conducted to date – with the Distributed Information Warfare Constructive Environment (DICE) application. It is used in Air Force simulation exercises to play red – or



DICE is used in Air Force exercises to play enemy air defense systems.

enemy air defense systems. The Chief, Exercises and Joint Operations Division, Department of the Air Force, wrote to Murri stating, "I would like to take the opportunity to recognize the superior effort you provided during the Millennium Challenge 2002... The experiment had over 13,000 service and joint participants, working at war fighting centers and ranges throughout the United States. The centerpiece of this effort is the simultaneous experimentation and examination of Joint, Service, and Special Ops 2007 concepts, capabilities, and

organizations... Your hard work, expertise, and devotion to duty was the primary reason fellow warfighters, soldiers, sailors, airmen, and marines were able to identify high-payoff warfighting recommendations. I certainly appreciate your critical efforts. It has been an honor and pleasure to serve with you and I look forward to the next opportunity to work with you in the defense of freedom and our great country."

- Kimberly McIntyre received the 2002 Lou Milam Next Step Scholarship. Established in memory of former employee Lou Milam, the scholarship is designed to encourage women in administrative support functions to advance themselves through education. Applicants must have completed a minimum of 15 semester credit hours and must be full-time employees. Two scholarships are awarded based on scholastic achievement, work performance and developmental potential.
- The Federal Bureau of Investigation wrote of Counterintelligence's Bonnie Hong, "The Salt Lake City office of the Federal Bureau of Investigation wishes to express its appreciation for your participation in the establishment of the Intermountain InfraGard Chapter ... Infragard would not be the thriving, vibrant organization it is today without your hard work and dedication." Hong continues her support of the cyber security organization. She will serve as chapter president in 2003.
- John Grandy received a patent on "Ambient Method and Apparatus for Laser Trace Constituent Analysis."
- David Harker received a patent on "Methods and Systems for Seed Planting Management and Control."



State of the Division

Laurin Dodd,
*Associate Laboratory Director,
National Security*


Every issue of this newsletter includes a column devoted to the Laboratory's Counterintelligence Program. Fundamental to doing business at a national laboratory is the

need to do work safely while protecting the environment and to assure that intellectual property is protected consistent with U.S. government and laboratory interests. Our

Counterintelligence Program plays a big role in helping to assure that proprietary and sensitive information at the INEEL is appropriately protected.

We may have the best Counterintelligence Program within the DOE laboratory system. During the month of July, the Laboratory underwent its annual counterintelligence inspection. Eight highly trained former counterintelligence agents from the FBI, CIA and military branches combed through every detail and operation of our CI Program. At the completion of the 10-day inspection, the Lab emerged with a flawless record.

Jack Way and his staff, Bruce Allbright, Chris Crandall, Bonnie Hong, Annmarie Hudson, Gene Johannes and Judy Wright are to be congratulated for a implementing a CI Program that is the first within DOE to received an *excellent* rating with no findings. This is an impressive team and I am proud to have them be part of our National Security Division. On a personal note, we wish Bruce Allbright the best as he has been called back to active duty for one year with the Office of Navy Intelligence. Bruce is an outstanding counterintelligence analyst and we will miss him for the next year.



Counterintelligence CORNER

Scams and Cons Defraud Internet Users

Contributed by: AnnMarie Hudson

Con artists have gone high-tech, using the Internet to defraud consumers in a variety of clever ways. According to available government statistics, the dot-com stock boom has gone bust, but dot-cons are exploding on the Internet, with unsuspecting consumers defrauded to the tune of \$3 billion a year. The average loss per victim is \$427 with others losing significantly more.

Cyber crime, which includes online auction hustles, stock schemes, quack health cures, identity theft, investment rip-offs, Nigerian scam letters, and credit card swindles, are proliferating like viruses despite enforcement efforts by a host of government agencies.

Cyber crime knows no boundaries. Sites that appear domestic may actually be from China, the Cayman Islands, Switzerland or any one of a number of other countries where U.S. authorities'

requests for help are not always met with enthusiasm.

At the INEEL, the common form of cyber crime is the Nigerian Scam Letter. There

are numerous variations to the letter, but all have the same purpose. The aim is to lure employees into fraudulent business relationships. The Nigerian letter has been sent throughout the world, where in some cases victims have ended in financial ruin and a few, in mysterious death. Under no circumstance should an employee travel to Nigeria to pursue this.

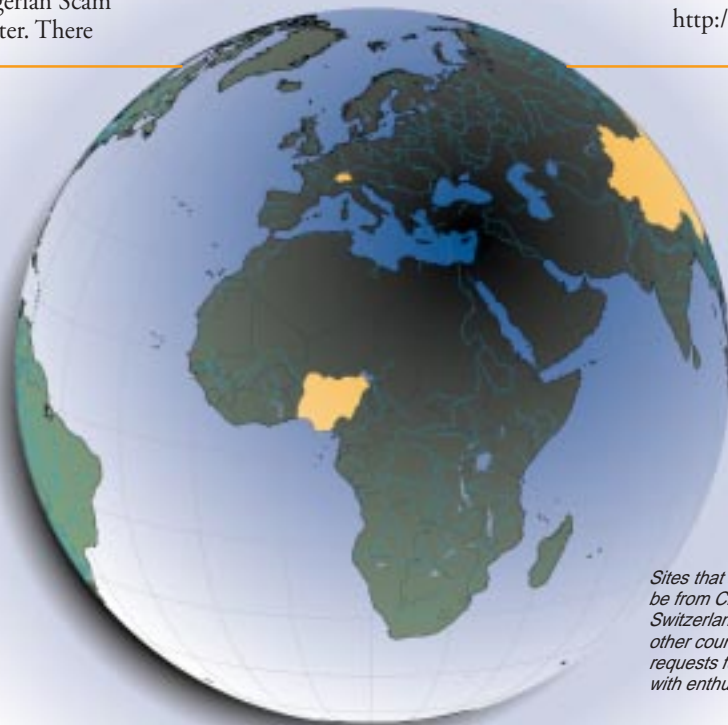
An example of one of the Nigerian letters appearing at the INEEL states, "I am Mr. Abiola Segun, CREDIT OFFICER with the UNION BANK NIGERIA PLC." The first sentence begins "First, I must solicit your confidence in this business transaction, this is by virtue of its nature as being

utterly CONFIDENTIAL and TOP SECRET."

If an INEEL employee receives e-mail believed to be a Nigerian Scam Letter, and if it is similar to letters received before, delete it. If it appears different, forward the e-mail to the Counterintelligence Office (hudsa@inel.gov), then delete it.

For more information on Internet scams:

- For Web auction fraud, contact: FBI/Justice Department at <http://www.ifccfbi.gov>.
- For pyramid schemes, identity theft or travel and vacation fraud, contact: Federal Trade Commission at <http://www.ftc.gov>
- For online investing fraud, contact: Securities and Exchange Commission at <http://www.sec.gov>



Sites that appear domestic may actually be from China, the Cayman Islands, Switzerland or any one of a number of other countries where U.S. authorities' requests for help are not always met with enthusiasm.



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Editor Kathy Gatens
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Photographers .. Mike Crane, Chris Morgan,
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